

# The potential vegetation diversity in the integrated coconut (*Cocos Nucifera* L.) and oil palm (*Elaeis guineensis* Jacq) system's potential plant diversity as cattle feed

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**Abstract.** Coconut and oil palm farms are only two examples of the numerous sources of ruminant feed. The goal of this research was to assess the forage potential of coconut and oil palm plantations in Kubu Raya Regency. The data collection approach in this study employed a non-probability sampling strategy with specific sampling technique. The experiment was carried out in two separate sites, each with a land area of 4 hectares, and thirty forage samples were collected at each site using a 100 cm by 100 cm quadrant. The findings revealed that coconut farms had a more diverse range of forage types, including coconut leaf sheaths, legumes, and grass, than oil palm plantations. Land covered by coconut trees produced 721 kg ha<sup>-1</sup> of feed, whereas land covered by oil palm trees only yielded 416 kg ha<sup>-1</sup>. With respective values of 1.64 AU Ha<sup>-1</sup> Year<sup>-1</sup> and 1.00 AU Ha<sup>-1</sup> Year<sup>-1</sup>, the maximum capacity in coconut and oil palm shaded regions demonstrated promising potential for the growth of ruminant livestock. In the Kubu Raya Regency, the vegetation diversity and potential for forage availability are influenced by variations in conditions between coconut-shaded and oil palm-shaded land.

## 1 Introduction

The livestock industry in West Kalimantan is essential to promoting regional economic growth, boosting community earnings, and supporting the supply of animal-based food. The restricted supply of sustainable forage, both in terms of quality and quantity, is one of the primary barriers to the growth of ruminant livestock, especially beef cattle.

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West Kalimantan's restricted forage availability is due to the inconsistent quality and continuity of forage production brought about by the small area available for it [1]. The limited availability of forage is partly due to the conversion of agricultural land to non-agricultural uses [2]. Under the shade of plantation crops, this scenario necessitates an integrated forage supply system. The kind of forage crop produced in the shade of plantation crops will naturally differ according to the species and degree of shade on the soil. Increased shade levels will impede the passage of sunlight to the soil surface, hence impairing photosynthesis in plants and reducing forage output.

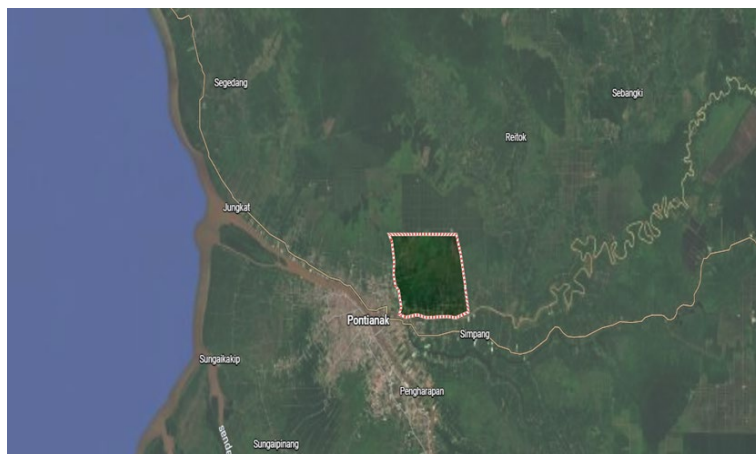
This issue can be addressed by an integrated system of livestock and plantation crops, which is one pertinent solution. By combining beef cattle ranches with coconut (*Cocos nucifera* L.) and oil palm (*Elaeis guineensis* Jacq.) plantations, we may enhance land use efficiency, boost forage availability, and enrich soil fertility by recycling organic matter. Grasses, legumes, and other native plants that grow beneath coconut and oil palm forests can provide a cheap and sustainable forage supply.

West Kalimantan's Kubu Raya Regency has enormous potential for oil palm and coconut farms. By making use of the variety of plants beneath the stands as a source of cattle feed, combining these two goods creates possibilities for creating an integrated crop-livestock system. Nonetheless, there is still little empirical evidence about the potential for plant variety in this region's integrated oil palm and coconut system. As a result, the goal of this research is to determine and assess the possibilities for plant variety in the integrated coconut and oil palm system in Kubu Raya Regency, where cattle are fed. The research results are anticipated to serve as the foundation for creating a sustainable, productive, and environmentally sound integrated plantation-livestock system in West Kalimantan.

## 2 Materials and Methods

### 2.1 Research location

The research was conducted in two different places located in Mega Timur Village, Ambawang District, Kubu Raya Regency, namely land with shade from coconut plants and oil palm plants, as shown in Figure 1.



**Fig. 1.** Map of Mega Timur Village, Ambawang District, Kubu Raya Regency, location for taking forage samples under coconut and oil palm shade.

## 2.2 Experimental design

This study used a non-experimental design. Data collection used a non-probability sampling technique, namely purposive sampling. Sampling points were intentionally selected at locations in coconut and oil palm shade areas.

## 2.3 Working Procedures

This study took place at two sites: one exposed to the sun in the Kubu Raya Regency's Ambawang District and one shaded by coconut and oil palm trees. Between 08.00 and 09.00, 13.00 and 14.00, and 16.00 and 17.00, light observations were made at three separate times. The instrument used for the measurement was a luxmeter, which uses a digital device (MIJIA Bluetooth hygrometer) to measure temperature, humidity, and light units/lumens. The luxmeter cover was opened, the tool was directed at the light source, and the readings were recorded on the luxmeter monitor screen to measure light. The temperature and humidity readings displayed on the instrument were recorded in the same manner as the temperature and humidity measuring instrument.

The starting point for forage sampling was chosen at random by picking a quadrant. Thirty forage samples were collected at each location, each of which had a land area of four hectares. Using a quadrant measuring 100 cm by 100 m, the first sample was taken ten steps to the right. The third sample was taken ten steps to the right of the second, which was taken 125 meters directly in front of the first. The collected forage was weighed for fresh weight before being placed in labeled plastic bags. To ascertain the dry matter content, the forage was then dried in a 60°C oven. The storage capacity was calculated after the dry matter weight of the forage had been established. Purposive sampling was used to gather the data. The data were then collected and examined using a descriptive methodology. The general conditions, forage production, and potential of the land utilized in the research were described using this descriptive method.

## 3 Results and discussion

### 3.1 Humidity, temperature, and light intensity

The amount of forage produced will depend on environmental factors like light, temperature, humidity, pH, and soil fertility. These elements will have an impact on how productive the forage is that is produced on a specific area of land. Photosynthesis, which is dependent on light, plays a key role in plant productivity. Because of variations in lighting, individual plants can display somewhat different morphological responses. For best development, different plant species require distinct light intensities [3]. Table 1 shows the findings of lighting levels in shaded land that is integrated with oil palm and coconut.

**Table 1.** Lighting intensity, temperature, and humidity in shaded areas for coconut and oil palm plants.

| Variable              | Time        | Type of shade |          |
|-----------------------|-------------|---------------|----------|
|                       |             | Coconut       | Oil Palm |
| Light intensity (Lux) | 08.00-09.00 | 4322±304      | 1985±148 |
|                       | 12.00-13.00 | 12460±624     | 3646±312 |
|                       | 16.00-17.00 | 3431±416      | 2227±274 |

|                  |             |      |      |
|------------------|-------------|------|------|
| Temperature (°C) | 08.00-09.00 | 30±2 | 26±2 |
|                  | 12.00-13.00 | 33±3 | 30±4 |
|                  | 16.00-17.00 | 31±1 | 28±1 |
| Humidity (%)     | 08.00-09.00 | 73±2 | 76±2 |
|                  | 12.00-13.00 | 76±4 | 89±3 |
|                  | 16.00-17.00 | 85±2 | 91±1 |

The results in Table 1 show that the daytime illumination levels in both research areas were highest under coconut shade lighting at 12,460 lux and tended to be lower in the oil palm -shaded area at 3,646 lux. The higher the shade level, the lower the light intensity reaching the ground surface. This information aligns with the opinion of [4] who stated that differences in shade levels affect light intensity, air temperature, air humidity, and soil temperature in the plant environment. Therefore, the light intensity received by several plants differs and affects the availability of light energy to be converted into heat and chemical energy. The general characteristics of grasslands without shade are longer grass stems, while in shaded areas, the grass grows shorter, has more leaves, and is lighter in colour. [5] stated that the higher the percentage of shade, the lower the number of leaves, the number of stolons, and the length of the plant stalks produced.

Temperature and humidity play a crucial role in the growth of forage. [6] also stated that forage plant growth is influenced by environmental conditions, temperature, rainfall, and light intensity. The results of temperature and humidity measurements in shaded areas of coconut and oil palm plantations are shown in Table 1.

The temperature in the coconut shaded area is higher than the oil palm shaded area, namely 30 °C in the morning, 33 °C during the day, and 31 °C in the afternoon, but has lower humidity. This is because, based on the conditions of the research location, the coconut shaded area has a less dense canopy/shade, so that sunlight can enter and reach the surface, causing high and low temperatures and low humidity. This occurs because high levels of light intensity are correlated with temperature, resulting in land with coconut shade being hotter. This statement is supported by [7], who stated that high temperatures are influenced by high light intensity. The greater the level of shade, the lower the air temperature and the higher the air humidity.

### 3.2 Potential for areas based on the dry matter production of forage

Land in West Kalimantan's ability to produce forage varies due to climate factors such as sunlight, temperature, and humidity. Forage plants are C4 plants that utilise high sunlight intensity for efficient photosynthesis. This means that land with high shade levels will exhibit lower forage productivity. The land potential and dry matter productivity of forage shaded by coconut and oil palm plantations are shown in Table 2.

**Table 2.** Potential for coconut and oil palm shade areas based on dry matter production of forage.

| Variable   | Type of shade |          |
|--|---------------|----------|
|  | Coconut       | Oil Palm |
| Dry matter production of forage kg ha <sup>-1</sup>      | 721           | 416      |
| AU carrying capacity ha <sup>-1</sup> year <sup>-1</sup> | 1.16          | 0.67     |

Based on the data shown in Table 2, there is variation in forage production across the two types of land analysed. Land shaded by coconut produced forage dry matter production of 721 kg ha<sup>-1</sup>, while land shaded by oil palm only achieved 416 kg ha<sup>-1</sup>. Land shaded by coconut showed higher forage production because the grass in this area received more sunlight, with less canopy obstruction, allowing C4 plants to grow optimally. Meanwhile, land shaded by oil palm showed lower forage production.

Based on the data in Table 2, the unshaded area showed higher dry matter yields for forage than the two protected areas. This phenomenon is caused by the need for forage plants to have ideal environmental conditions for their growth. Temperature and humidity play a crucial role in plant development. This is in line with [8] statement that air and soil humidity, air and soil temperature, are microclimate factors that significantly influence plant growth, and each of these factors is interconnected to create an optimal environment for plants. Plant growth increases with increasing temperature and decreasing humidity, and vice versa.

Plant productivity is closely related to the maximum capacity of an area, so it is important to balance livestock numbers and forage productivity to prevent under- or overgrazing. Maximum capacity refers to the land's ability to support livestock without causing damage to the grass. The results showed that maximum capacity in coconut and oil palm shaded areas showed good potential for ruminant livestock development, with values of 1.64 AU Ha<sup>-1</sup> Year<sup>-1</sup> and 1.00 AU Ha<sup>-1</sup> Year<sup>-1</sup>, respectively. This occurs because the amount of land holding capacity depends on its green production. The holding capacity of one location varies from another due to differences in rainfall, soil productivity, topography, and other factors [9].

### 3.3 Identification of forage

Identifying forage types is crucial for understanding the diversity of forage plants in coconut and oil palm. The variety of forages in the three research locations certainly differed, influenced by climate and soil nutrient content. Data on forage identification in coconut-shaded and oil palm-shaded areas can be seen in Table 3. The coconut tree shade area has 41 species, while the oil palm shade area has 23 species. This difference in the number of species growing is caused by competition for nutrients in the plants.

Based on the results of this study, it shows that higher vegetation diversity occurs under coconut shade. Coconut plantations typically have wider tree spacing and a more open canopy, allowing greater sunlight penetration. This condition supports the growth of diverse plant groups such as grasses (*Digitaria decumbens*, *Chloris gayana*), legumes (*Desmodium triflorum*, *Neptunia plena*), broadleaf weeds (*Ageratum conyzoides*, *Cyanthillium cinereum*), and ferns (*Dicranopteris linearis*, *Nephrolepis biserrata*). The presence of legumes is especially advantageous because they contribute nitrogen to the soil, promoting a supportive environment for a variety of forage species.

These results are consistent with findings by [9], who reported that coconut plantations in North Sulawesi supported a rich understory vegetation due to higher light penetration, resulting in better forage availability. Similarly, [10] observed that coconut-based farming systems in the Philippines tend to have higher herbaceous plant diversity than other plantation types with denser canopies.

Based on the results of this study, it shows that lower diversity occurs under oil palm shade. In contrast, oil palm plantations, especially those in productive age groups, typically have denser and wider frond layers, leading to reduced light intensity reaching the soil surface. The lower light levels measured in this study correspond with reduced species richness in the oil palm area. The species present tend to be shade-tolerant grasses and herbs, including *Axonopus compressus*, *Paspalum conjugatum*, *Fimbristylis dichotoma*, and *Mikania micrantha*. These species are known for their ability to survive under moderate to heavy shade conditions.

**Table 3.** Grass species found in coconut and oil palm shaded areas.

| Latin Name                        | Type of shade |          |
|-----------------------------------|---------------|----------|
|                                   | Coconut       | Oil palm |
| <i>Ageratum conyzoides</i>        | v             | v        |
| <i>Axonopus compressus</i>        | v             | v        |
| <i>Axonopus fisifolius</i>        | v             |          |
| <i>Bacopa monnieri</i>            |               | v        |
| <i>Brachiaria mutica</i>          |               | v        |
| <i>Carex pendula</i>              | v             |          |
| <i>Ceratopteris thalictroides</i> | v             |          |
| <i>Chloris gayana</i>             | v             | v        |
| <i>Colocasia esculenta</i>        | v             | v        |
| <i>Colubrina asiatica</i>         | v             |          |
| <i>Commelina diffusa</i>          | v             |          |
| <i>Cosmos caudatus</i>            | v             |          |
| <i>Cyathillium cinereum</i>       | v             |          |
| <i>Cyperus brevifolius</i>        | v             | v        |
| <i>Cyperus mindorensis</i>        | v             | v        |
| <i>Cyperus rotundus</i>           |               | v        |
| <i>Desmodium triflorum</i>        | v             |          |
| <i>Dicranopteris linearis</i>     | v             |          |
| <i>Digitaria decumbens</i>        | v             | v        |
| <i>Echinochloa colona</i>         | v             |          |
| <i>Emilia sonchifolia</i>         | v             |          |
| <i>Fimbristylis dichotoma</i>     | v             | v        |
| <i>Fimbristylis littoralis</i>    | v             | v        |
| <i>Fimbristylis miliaceae</i>     | v             |          |
| <i>Hyptis brevipes</i>            | v             |          |
| <i>Imperata cylindrica</i>        |               | v        |
| <i>Isachne globosa</i>            | v             |          |
| <i>Justicia procumbens</i>        |               | v        |
| <i>Melastoma malabathricum</i>    | v             |          |
| <i>Mentha spicata</i>             | v             |          |
| <i>Mikania micrantha</i>          | v             | v        |
| <i>Microstegium vimineum</i>      | v             |          |
| <i>Nephrolepis biserrata</i>      | v             |          |
| <i>Neptunia plena</i>             | v             |          |

|                           |   |   |
|---------------------------|---|---|
| Ottochloa nodosa          | v |   |
| Panicum hemitomon         |   | v |
| Paspalum conjugatum       | v | v |
| <i>Paspalum dilatatum</i> | v | v |
| Paspalum scrobiculatum    | v |   |
| Phyllanthus niruri        | v | v |
| Richardia scabra          | v | v |
| Scirpus ternatanus        | v |   |
| Spermacoce verticillata   | v | v |
| Spermatococe alata        | v | v |
| Stenochlaena palustris    | v |   |
| Torenia crustacea         | v |   |
| Uncaria rhynchophylla     | v | v |

The findings align with [11], who reported that vegetation diversity under oil palm plantations in West Kalimantan is significantly lower because heavy shading limits seed germination and the growth of light-demanding forage species. Furthermore, demonstrated that dense shade reduces tiller production, leaf number, and photosynthesis in most forage grasses, explaining the limited species count in oil palm sites.

#### 4 Conclusion

The differences in conditions between coconut shaded and oil palm shaded areas affect vegetation diversity and the potential for forage supply. Coconut shaded areas have a better carrying capacity, making them more suitable for ruminant livestock development than oil palm shaded areas.

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